

**FOUNDATIONS FOR SUCCESS: DEVELOPING EFFECTIVE MATHEMATICS
EDUCATORS THROUGH COGNITIVELY GUIDED INSTRUCTION**

Project Design

The *Foundations for Success: Developing Effective Mathematics Educators through Cognitively Guided Instruction* project will enhance the effectiveness of elementary mathematics teachers through large-scale implementation of a long-term professional development (PD) program for elementary teachers called Cognitively Guided Instruction (CGI).

Project Goals

The *Foundations for Success* project aims to:

- (1) Provide CGI-based PD in mathematics for 2,790 elementary teachers in Florida
- (2) Improve teachers' knowledge of mathematics, knowledge of well established learning progressions in number, operations, and algebraic thinking, and ability to understand and express mathematical ideas using a variety of visual and symbolic representations,
- (3) Increase teachers' implementation of evidence-based practices in mathematics instruction,
- (4) Increase students' mathematics achievement with a focus on traditionally underserved and underrepresented students by enhancing CGI to meet their needs, and
- (5) Establish structures to support teachers' sustained use of high-quality mathematics instruction beyond the grant award period.

Brief Project Description

Over a five-year period, the *Foundations for Success* project will provide evidence-based PD in mathematics for 2,790 elementary teachers and 120 elementary school principals. Through these educators, the program will impact more than 142,312 students in urban, suburban, and rural settings during the five-year period and numerous additional students in subsequent years

through the continued work of these teachers. Working with an advisory board with extensive expertise and experience supporting equity and access in mathematics, the *Foundations for Success* program will integrate evidence-based practices in early mathematics, fractions, and problem solving with promising practices for teaching traditionally underserved and underrepresented students (and their teachers) in mathematics. The program evaluation design will use several complementary methodological approaches, including (1) a mixed-methods evaluation of implementation to determine the extent to which the program is being implemented as intended, (2) a multisite cluster-randomized trial to enable causal inference regarding teacher and student outcomes, and (3) an exploratory study investigating factors in classroom instruction that mediate the impact of the CGI intervention on student achievement.

Support for SEED Program Priorities

The *Foundations for Success* project addresses Absolute Priority 1 (Supporting Effective Teachers), and Competitive Priority 1 (Promoting Science, Technology, or Mathematics). The *Foundations for Success* program will provide Cognitively Guided Instruction (CGI) PD to elementary teachers in Florida. The CGI PD program promotes STEM education through its focus on elementary school mathematics instruction through a problem-solving approach. As described in the subsequent sections, many of the core elements of the CGI PD program meet the What Works Clearinghouse standards for moderate evidence of effectiveness.

Absolute Priority 1 (Supporting Effective Teachers) and Competitive Preference Priority (Promoting STEM Education). The CGI PD program to be implemented in the *Foundations for Success* project workshops will be designed and coordinated by the project's CGI Implementation Director, Linda Levi, a member of the CGI research and development team since 1989. The name Cognitively Guided Instruction is not trademarked, and there are a variety

of publicly available Cognitively Guided Instruction resources as well as a variety of CGI PD offerings for teachers, so it is important to note that Dr. Levi was a member of the team that designed and delivered CGI PD to teachers in the two extant studies of CGI PD that meet WWC standards without reservations as well as other studies referenced in this proposal.

The proposed CGI PD program is a long-term professional-learning program in which each teacher can participate in up to three years of CGI PD. There are eight seven-hour days of PD each year, resulting in 56 hours per year of direct contact. At least four of these days each year happen during the school year to ensure teachers receive follow-up support for translating the knowledge and skills they learn in the workshops into implementation in the classroom. Teachers have many opportunities to work with students during the CGI PD sessions.

In order to focus on developmental progressions associated with students at specific ages there are two tracks of CGI PD: one for grades K–2 teachers and one for grades 3–5 teachers. The K–2 CGI PD program will focus on the following taxonomies for problem types and developmental progressions regarding: whole number addition and subtraction; base ten concept for whole numbers; and early algebraic thinking. The 3–5 CGI PD program will focus on these taxonomies for problem types and development progressions: whole number multiplication and division; fraction concepts and operations; base ten concepts for whole numbers and decimals; and early algebraic thinking.

CGI PD supports teachers to engage in the following practices, which are included in the list of evidence-based recommendations in three IES Practice guides focused on elementary mathematics (Frye et al., 2012; Siegler et al., 2010; Woodward et al., 2012):

- A. Teach number and operation using a developmental progression.** The main goal of CGI PD is increasing K-5 teachers' abilities to use developmental progressions to guide

their instructional decisions as they teach number and operations on whole numbers and fractions. Details of how CGI PD meets this goal are described in the context of the practices recommendations below.

B. Use progress monitoring to ensure math instruction builds on what each student

knows. Progress monitoring can be challenging because it's hard for teachers to efficiently assess each of their student's ever-changing mathematical knowledge. The developmental progressions used in CGI PD are highly structured and grounded in a robust body of empirical evidence. Understanding these progressions allows teachers to efficiently link a student's strategy for solving a problem to a specific level of understanding the concept embedded in the problem which makes progress monitoring more efficient.

C. Prepare problems and use them in whole-class instruction . Teachers in CGI PD learn

to use what they learn from progress monitoring to write problems to build on what each student knows. Writing problems starts with identifying a learning goal related to a Florida Math Standard. Teachers use what they learn from progress monitoring to choose or design a problem that will engage each student with this standard at an appropriate level so that their understanding grows. Different students within the same class will have different levels of understanding. There are two main strategies that teachers in CGI PD learn about to accommodate these differences during whole-class instruction.

1. *CGI PD supports teachers to plan lessons in which students generate their own strategies for solving problems.* When students generate their own strategies for solving problems, most students choose strategies that are aligned with their most sophisticated understanding of the concepts in the problem. Teachers learn to

recognize when students aren't using appropriate strategies and support them to do so. CGI teachers vary in how often they engage students in lessons in which students generate their own strategies for solving problems.

2. *Teachers in CGI PD learn to provide different number choices for a common problem, enabling differentiated instruction and personalized learning opportunities.* Here is an example of a problem with different number choices that a fourth-grade teacher presented to her class.

Tylesha's sister has braids in her hair. She has ____ braids with ____ beads on each braid. How many beads does she have in her hair?

(20, 4) (20, 8) (42, 4) (56, 8)

Students as young as first grade can learn to choose a set of numbers and put the first number in the first blank and the second number in the second blank before solving the problem.

- D. Expose students to multiple problem-solving strategies.** Teachers in CGI PD learn to facilitate whole-class discussions of the different strategies that students used to solve a problem. After each student has had the opportunity to solve a problem, the teacher chooses 3 or 4 students to present their solution strategy to the class. Teachers learn how to use development progressions to deliberately choose which strategies students will share and how strategies can be sequenced so that students can see connections among strategies. Teachers learn when and how to suggest that a student try a specific strategy to solve a problem.
- E. Teach students to use visual representations .** Teachers in CGI PD learn how to design problems which at least some of their students will naturally solve using visual

representations. Teachers learn to support all students' use of visual representations through discussions of these strategies and learn how to support their students to connect visual representation with abstract strategies.

F. Help students recognize and articulate mathematical concepts and notation.

Presenting solution strategies to classmates requires that students are able to articulate mathematical concepts. Teachers learn to how to support students to articulate their understanding of mathematical concepts. CGI PD sessions devote a great deal of time to supporting teachers to understand how mathematical notation that can be used to represent how a student solved a problem.

G. Build on students' understanding of sharing to develop initial fraction concepts.

Teachers in CGI PD learn how to write Equal Sharing problems to develop students' initial understanding of fractions as well as how students' strategies for Equal Sharing problems are connected to learning progressions. Teachers learn how to design lessons around Equal Sharing problems.

H. PD programs should place a high priority on improving teachers' understanding of fractions and how to teach them

The CGI 3–5 program devotes over half of its time each year to fractions. Teachers develop their understanding of fractions by solving problems, analyzing students' strategies for solving problems, and linking students' strategies to Florida Math Standards related to fractions. CGI PD supports teachers to use these practices described above in their fraction instruction in the same manner that it supports teachers to use these practices in their whole-number instruction.

These eight practices are highly aligned with nearly all of the evidence-based recommendations put forth in the IES Practice Guides for teaching mathematics to young children (Frye et al.,

2013), effective fractions instruction (Siegler et al., 2010), and improving mathematical problem solving (Woodward et al., 2012).

Strong Partnership with Established Record of Success

The *Foundations for Success* project forms a collaborative partnership between Florida State University, The CGI Math Teacher Learning Center, the University of Miami, the Florida Department of Education, Pinellas County Schools, Okaloosa County Schools, Leon County Schools, St. Johns County School District, Bay District Schools, and several other local education agencies representing public schools in the state of Florida. These named agencies have already committed to participation in the program, and their letters of agreement are provided in the Appendices. The opportunity to join the partnership will be extended to additional urban, rural, and suburban public school districts in Florida (including publicly funded charter schools) in the first two months of the project.

This partnership has already demonstrated record of success in large-scale CGI projects in Florida. Dr. Robert Schoen (Project Director) served as the principal investigator and third-party evaluator for three large scale implementation and evaluation Florida CGI projects. Dr. Linda Levi (Implementation Director) designed the CGI PD and supervised the delivery of the PD for each of these projects. Dr. Schoen, through his previous role as the state supervisor of mathematics, has strong working relationships with district curriculum supervisors in mathematics across the state of Florida and has a strong record of success in developing partnerships with Florida school districts to deliver large-scale, complex projects. He has served as the associate director of FCR-STEM, a research center established in statute by the Florida Legislature with a mission to improve STEM education in Florida, for the past nine years.

The CGI Math Teacher Learning Center is well positioned to provide CGI PD to teachers in this study. Linda Levi, the Director of this Center, has been involved in CGI research and development since 1989 and is an author of three CGI books for teachers that the PD will be based on. (Carpenter, Fennema, Franke, Levi & Empson, 1999; 2015; Carpenter, Franke & Levi, 2003; Empson and Levi, 2011). Each CGI Math TLC workshop leader has been working with Dr. Levi for at least 8 years. As the largest single group of CGI PD providers in the world, this group of CGI workshop leaders has provided up to 82 CGI PD sessions a year nationwide to a diverse group of teachers and schools.

Focusing on Students with the Greatest Needs

Statewide achievement data from the past three years in Florida indicate there remain strikingly large achievement gaps in mathematics for many subgroups of the population, especially for Black students, students classified as English-language learners, and economically disadvantaged students. Figures 1 and 2 show longitudinal trends for the percent of students in these subcategories who are achieving at or above grade level in mathematics. While the gap may be very slowly narrowing, it remains true that less than half of Black students and economically disadvantaged students are meeting basic competency for their grade level in mathematics.

The *Foundations for Success* project will concentrate program resources on students and teachers who represent these traditionally underserved and underrepresented groups. In Florida, 22% of the K–12 student population has been identified as Black, and 35% of the student population has been identified as Hispanic. During the teacher recruiting and enrollment phase each year, we will give priority to teachers working in schools eligible for Title I status and/or schools wherein the percentage of Black or Hispanic students are higher than the state average.

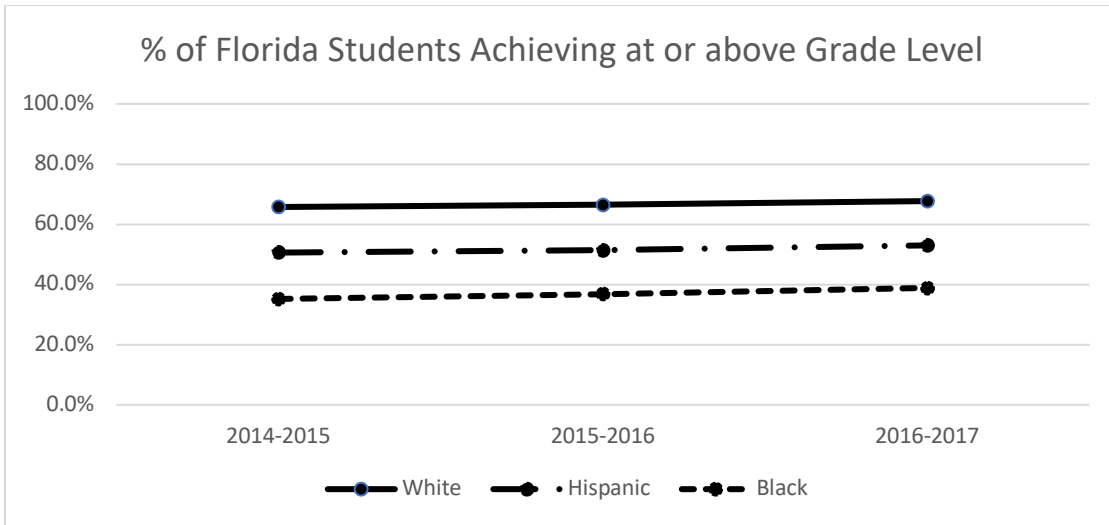


Figure 1. Percentage of Florida students achieving at or above grade level on the Mathematics Florida Standards Assessment over the past three years, split by the three race and ethnicity reporting categories in Florida.

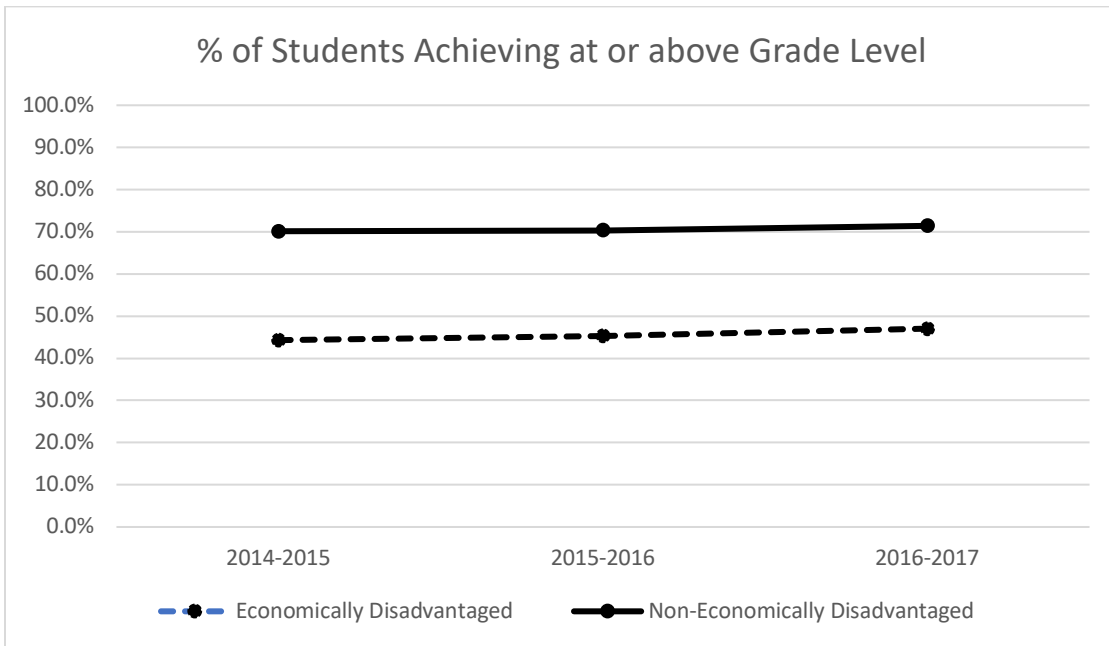


Figure 2. Percentage of Florida students achieving at or above grade level on the Mathematics Florida Standards Assessment over the past three years, split by whether the students are considered economically disadvantaged or not.

In each year of the program, at least 60% of participating teachers will meet at least one of the following conditions: identify as Mixed race or Alaskan/Native American; teach in a Title I school; teach in a school where more than 22% of the student population is identified as Black; teach in a school where more than 35% of the student population are identified as Hispanic.

Annual Mathematics Access and Equity Conference (MAEC)

Supporting teachers to meet the needs of traditionally underserved students will be integrated with every aspect of CGI PD. Project teachers will have an additional opportunity to attend an annual *Mathematics Access and Equity Conference* (MAEC). The format and focus of the MAEC will be modeled after related programs, such as the McKnight Fellowship, which has been highly successful in promoting African Americans and Hispanics in Florida to complete post-secondary education, including PhDs, through a comprehensive system of support. The MAEC will provide teachers with opportunities to support each other in creating and sustaining access and equity in their classrooms and share information with project staff regarding successes and challenges related to using CGI to create access and equity. Subsequent CGI PD will be modified to provide these teachers with support specific to their challenges as well as support so that all teachers in the project can learn from success stories shared at MAEC. Members of the advisory board will provide support during the MAEC by leading sessions devoted to their individual areas of expertise including: implicit biases in mathematics education, critical pedagogy and equity through mathematics, mathematics education for social justice, and culturally responsive mathematics pedagogy. At the end of each conference, each attendee (teachers, advisory board members and project staff) will write their own, personal commitment to act. Structures to sustain on-going support for these commitments will be developed among

the attendees with the goal of creating a social network of teachers who will identify as champions of access and equity in mathematics.

Summary of Project Design

The *Foundations for Success* design is an exceptional approach to the absolute and competitive priorities for many reasons. The senior personnel in the partnership have been successfully implementing CGI PD for teachers in Florida for the past five years and have demonstrated that they have the ability to implement a project of this magnitude. The core component of the program, CGI-based PD, has a well-established record of success in increasing teacher quality and student achievement in incorporates many evidence-based practices in teacher PD and mathematics instruction.

Significance

There have been many studies of the effects of CGI teacher PD. CGI intervention programs have been the subject of several randomized controlled trials (Carpenter, et al., 1989; Jacobs et al., 2007; Schoen et al., 2017; Schoen et al., in process). Carpenter et al. (1989) did not reported effect sizes, but Slavin and Lake (2007) estimated the magnitude of teacher-level effects on student achievement in the Carpenter et al. study to be 24 percent of the standard deviation, which is large enough to be practically meaningful if not statistically significant. Jacobs et al. (2007) reported statistically significant, positive effects of a CGI-based intervention program on several teacher- and student-level factors, including student achievement.

CGI PD has been implemented in thirteen Florida school districts over the past four years. Two large-scale randomized controlled trials of CGI PD have occurred in Florida during this period of time. Both studies resulted in large, statistically significant effects on teachers' mathematical knowledge for teaching and reported beliefs about teaching and learning (Schoen,

Secada, & Tazaz, 2015; Schoen & Kisa, manuscript in preparation; Schoen & Ganley, manuscript in preparation). Evaluating the impact of the first year of the CGI PD on student achievement in Florida, Schoen et al. (2017) reported a range of positive effects across the first two years of implementation as measured by the MPAC interview (Schoen, LaVenita, Champagne, & Farina, 2016) and the Iowa Test of Basic Skills (Dunbar et al., 2008). Positive effect size estimates ranged from 6 percent to 20 percent of a standard deviation in school mathematics achievement. Evaluating the first year of the CGI PD with a sample representing seven Florida school districts in the 2015–16 school year, Schoen et al. (manuscript in progress) found that the intervention had a total effect size of $g = .17$ (p -value = .015) following the first year of implementation. The latter study is one of two extant studies of CGI PD that meet WWC standards without reservations and show potentially positive effects of the CGI program on student achievement in mathematics.

Early mathematics achievement is a strong predictor of future academic achievement. Student mathematical knowledge and achievement in preschool and the earliest grades predicts later school success in the elementary years and even through high school (Duncan, 2007; Cross, Woods, & Schweingruber, 2009; National Math Panel, 2008). High school mathematics achievement, in turn, predicts completion of university-level science degree across various fields in the sciences as well as or better than high school science achievement (Sadler & Tai, 2007). Mathematics achievement also predicts achievement in other curricular areas, including reading and science, and early knowledge of mathematics may be an even better predictor of later reading achievement than early reading skills (Duncan, 2007). Taken together, these findings emphasize the critical importance of providing a strong start for all students in early grades mathematics as a strategy to increase student learning in STEM and other subjects.

Teacher quality and retention are key strategies to improving STEM education, especially in high-needs schools. There is a well-established shortage of high-qualified mathematics and science teachers in the United States. Ingersoll, et al. have shown that this is particularly true in high-poverty schools serving high-needs student populations. They also showed that the shortage is not a problem of recruitment. Rather, it is a problem of retention. Their research suggests that PD opportunities and support for more teacher autonomy in schools serving high-needs populations are promising solutions to this nationwide problem (Ingersoll & May, 2010; Ingersoll, Merrill, & May, 2012).

Empirical research indicates teachers at the early elementary level tend to have lower levels of knowledge and preparation in mathematics than secondary-level teachers, and low levels of teachers' mathematical knowledge for teaching are associated with lower student achievement. Hill, Rowan, and Ball (2005) found that the effect of teachers' mathematical knowledge for teaching on student achievement is commensurate with the effect of socioeconomic status on student achievement. Their findings suggest that a focus on teachers' subject-matter knowledge—a factor within the locus of control of the school system—may help to neutralize the effect of poverty—a factor outside the locus of control of the school system—on student learning in mathematics.

CGI has a well-established track record of supporting equity and inclusion and excellence in mathematics. As previously described, there exists moderate to strong evidence of effectiveness for CGI PD. Other research suggests the CGI approach is as effective, if not more effective, at increasing mathematics learning for students with disabilities (e.g., Behrend, 2003), Latino students (Turner & Celedón-Pattichis, 2011), students in high-poverty schools (Jacobst al., 2007), and African-American students (Ladson-Billings, 2000)

Cost Analysis

Looking at the cost of the CGI PD and the MAEC attendance each year, we estimate a per-teacher cost of \$2,100. Using a similar method, we estimate a per-pupil cost of \$105 for the *Foundations for Success* program based on the number of Florida students expected to be impacted by the program during the five-year project period. These cost estimates will be updated in project years 3 and 5 based on actual costs and best practices in cost analysis.

Sustainability

A secondary goal of the *Foundations for Success* project is to provide a brief training session to school principals to make them aware of the research and teaching methods proposed in the CGI teacher-training program and provide them with guidance for supporting their teachers. These training sessions will help with providing a long-term resource in the state of Florida for teachers. We have experienced in past projects that when a principal is exposed to the content for which the teachers are exposed and expected to implement, the likelihood of implementation of the program by teachers increases due to support of administrators in the school building. Therefore, providing this short training and meeting with principals yearly to provide updates will help with long term success and sustainability in each participating school.

Dissemination

The dissemination plan for this project is multi-faceted and involves all stakeholders from state policy makers all the way to parents and the general public. Over the years through the high quality of work conducted by Dr. Schoen, he has developed a strong working relationship with both state and district officials in Florida and has found that providing regular briefs of project status and results helps to foster support from the administration. This project will continue this tradition with annual meetings with state and district officials. These meetings will also provide a

space for district leaders to discuss the specific long and short term mathematics goals they have for their students and provide feedback to project staff on how CGI can help address those goals. Senior project personnel will meet annually with state policy makers to discuss outcomes from the program and to share teacher experiences. The goal of these meetings is to provide state policy makers not only the results of the study but to provide them with a window into the CGI classroom from the eyes of both the teacher and the student so that they can experience for themselves some of the outcomes of the program.

Lastly, project staff will present results from the research study at local and national conferences. This dissemination of results is important to the advancement in the field and to provide guidance to other interested groups in conducting a scale-up teacher training program. While we understand that participation in research conferences might limit the dissemination of the results to those that attend, to help broaden the dissemination of the results, a project website will also be created so that reports and results are made publically available.

Management Plan

Measurable Objectives

In the following sections, we list each of the major project goals and detail relevant, measurable strategies and objectives that will enable us to determine whether those goals are being met. Additional details are provided in the separate Performance Measures document.

Goal 1: Provide CGI-based PD in mathematics for 2,790 elementary teachers in Florida.

Measurable Objectives for Determining Progress toward Attaining Goal 1:

-
- 1.1 By December 15, 2018, recruit 210 teachers to enroll in the 8-day CGI PD program to be implemented during the 2018–19 school year.

- 1.2 During the 2018–19 school year, provide 8 days (56 hours) of the CGI PD program for 210 teachers. (Measure: Attendance sheets from CGI workshops)
- 1.3 By May 15 of each subsequent project year, recruit the required number of elementary teachers to apply to participate in the CGIPD program and consent to participate in the associated randomized controlled trial. In spring 2019–2023, this is 1,320 teachers (660 treatment, 660 control), 1,440 teachers (720 treatment, 720 control), 1,320 teachers (660 treatment, 660 control), and 540 teachers, respectively. (Measure: Enrollment lists and lists of consenting teachers)
- 1.4 During the summer and school year of each subsequent project year, provide 8 days (56 hours) of the CGI PD program for the target number of Florida elementary teachers assigned at random to the treatment group. This is 210, 660, 720, 660, and 540 teachers in each respective school year from 2018–19 through 2022–23. (Measure: Attendance sheets from CGI workshops)

Goal 2: Increase teachers’ knowledge of mathematics and student learning progressions,

Measureable Objectives for Determining Progress toward Attaining Goal 2:

- 2.1 Increase K–5 teachers’ mathematical knowledge for teaching during each year of project implementation (Measures : Knowledge for Teaching Early Elementary Mathematics (Schoen, Bray, Wolfe, Nielsen, & Tazaz, 2017); Learning Math for Teaching (Hill, Schilling, & Ball, 2004))

Goal 3: Increase teachers’ implementation of evidence-based practices in math instruction,

Measureable Objectives for Determining Progress toward Attaining Goal 3:

- 3.1 Teachers assigned at random to the treatment condition will maintain higher levels of academic rigor (e.g., cognitive demand) and quality of classroom discourse in

mathematics instruction in project years 2, 3, and 4 than their peers in the counterfactual condition (Measure: Instructional Quality Assessment (Boston, 2012))

Goal 4: Increase students' mathematics achievement with a focus on traditionally underserved and underrepresented students by enhancing CGI to meet their needs.

Measureable Objectives for Determining Progress toward Attaining Goal 4:

- 4.1 During each project year, at least 60% of participating teachers will meet at least one of the following conditions: identify as Black, Hispanic, or Native American; teach in a Title I school; teach in a school where more than 22% of the student population is identified as Black; teach in a school where more than 37% of the student population are identified as Hispanic.
- 4.2 Complete and publish literature review focused on scaffolding in elementary-school mathematics for low-performing students in project year one.
- 4.3 Review and analyze evaluation data from previous CGI implementation in Florida to identify teachers' difficulties in implementing CGI in high-poverty schools in project year one.
- 4.4 Pilot-test scaffolds to support teacher implementation of CGI in high-poverty schools.
- 4.5 During project years one through four, conduct focus group interviews involving teachers and instructional support personnel in high-poverty or high-minority schools.
- 4.6 In project year one, make recommendations for revision to CGI training materials in response to needs of teachers in high-poverty or high-minority schools; revisit the recommendations each year based on subsequent focus-group interviews and other formative evaluation data.

- 4.7 In project years two through five, hold annual *Mathematics and Equity Conference* conference for teachers in the CGI program who are working in high-poverty schools and document a written commitment to action for each participant in the conference.
- 4.8 During project years three through five, contact every teacher who wrote a commitment to action in the previous year's *Mathematics and Equity Conference* conference and follow up on progress and needs.
- 4.9 In year two, create social media-based space for teachers in CGI program to share ideas and support one another between conferences and CGI training sessions.
- 4.10 During project years two through five, create weekly posts on social network platform to encourage teachers in CGI program to share ideas and support one another between conferences and CGI training sessions.

Goal 5: Establish structures to support teachers' sustained use of high-quality mathematics instruction in Florida beyond the grant award period.

Measureable Objectives for Determining Progress toward Attaining Goal 5:

- 5.1 Establishment of a definition of the key components of the definitive CGI PD model in Florida based on consensus of the Florida Department of Education, The CGI Math Teacher Learning Center, and the *Foundations for Success* Partnership Board. (Measure: Written report endorsed by partner agencies and published on project website).
- 5.2 Create a cadre of CGI-knowledgeable school principals through a two-year program with four days of face- to-face PD each year. In years one and two, 90 principals will participate. In year three, 75 will participate. In year four, 30 will participate.

Qualifications and Roles of Project Personnel

In the role of *Project Director*, **Robert Schoen** will oversee the implementation, evaluation, and fiscal management of the *Foundations for Success* program. He will coordinate quarterly meetings of the Partnership Board, which will consist of members representing each of the partner school districts, the Florida Department of Education, the University of Miami, Florida State University, and The CGI Math Teacher Learning Center. He will convene annual meetings of the project Advisory Board. He will chair monthly management team meetings involving senior personnel representing the CGI Math Teacher Learning Center, Florida State University, and the University of Miami. Working with the points of contact for each of the partner LEAs, he will recruit teacher participants for the PD. He will oversee the work of an experienced team that will conduct the evaluation of implementation and impact of the CGI program on teachers and students.

Robert Schoen is highly qualified for this role. As previously mentioned, he served as principal investigator on three large-scale randomized controlled trials of CGI, state supervisor of mathematics at the Florida Department of Education, and has served as the associate director of FCR-STEM . He currently serves as principal investigator of a large-scale, randomized trial co-principal investigator on an IES-funded, large-scale randomized controlled trial of Lesson Study with Fractions Resource Toolkits. He served as a co-PI on a large-scale implementation and three randomized control trials of Florida's Mathematics Formative Assessment System (Lang, Schoen, LaVenía, & Oberlin, 2014; Lang et al., 2013; Lang et al., 2011; LaVenía, 2016). He has a strong record of success in developing partnerships with Florida school districts to deliver large-scale, complex projects.

As the ***CGI Implementation Director, Linda Levi*** will design the core CGI program , provide on-going support and supervision to the CGI workshop leaders and provide technical assistance with the coordination of the CGI workshops. Dr. Levi will oversee the hiring, ongoing training and certification, and deployment of CGI workshop leaders to maintain the exceptionally high standards of the CGI program. She will work closely with the advisory board and the Diversity and Cultural Equity Director to ensure the CGI program is supporting all teachers in the CGI program with incorporating effective teaching practices that acknowledge the background and learning needs of students of color, emerging bilingual students, economically disadvantaged students and students with disabilities. She will also work closely with school leaders to ensure that the CGI program supports school wide and district wide educational improvement plans.

As was previously mentioned, Dr. Levi has been involved in CGI research and development for over 30 years in a variety of capacities. She and her colleagues have provided CGI PD to approximately 700 Florida teachers over the past 5 years. Through the course of that work, she has developed CGI PD materials specific to the Florida Math Standards and needs of Florida teachers.

The ***Diversity & Cultural Equity Director, Walter Secada*** will monitor and advise efforts to develop and enhance the CGI program to promote cultural competence and diversity in the teacher training and school classroom. As the Senior Associate Dean of the School of Education at the University of Miami and a Professor of Teaching and Learning, Dr. Secada has an extensive background working to advance the needs of culturally diverse teachers and students. Walter Secada served as the director of the U.S. Department of Education's Hispanic Dropout Project. He also served as the associate director and co-principal investigator of Promoting

Science among English Language Learners (P-SELL) with a High-Stakes Testing Environment, and as director and principal investigator of Language in Mathematics a program intended to create a teacher PD program geared towards providing teachers with tools to better teach mathematics to their English language learner students. He served as the director of an NSF-funded regional laboratory in the upper Midwest and introduced CGI to Native American schools (Secada & Brandefur, 2000). Currently, Walter Secada is serving a two-year appointment on NASA's Scientific Advisory Council. Dr. Secada will oversee the work of three graduate students who will assist in monitoring and developing the focus on diversity and inclusion in the CGI program.

The **Lead Project Manager, Amanda Tazaz** will monitor overall project activities ensuring a constant line of communication between project staff, partners, and teacher participants. Dr. Tazaz has extensive experience in managing projects of similar magnitude, including three large-scale projects involving implementation of CGI in Florida. Drawing on her experiences as a first-generation African American and a McKnight Doctoral Fellow, she will coordinate the annual MAEC meeting, designed to provide social and PD support for teachers serving high-poverty schools.

The **Partnership Board** will consist of at least one person from each of the partner institutions. These included the Florida Department of Education, Florida State University, University of Miami, CGI Math Teacher Learning Center, Pinellas County Schools, Leon County Schools, Bay District Schools, Okaloosa County Public Schools, St. Johns County District Schools, and the remaining school district partners that will be added in the first three months of the project. The Partnership Board will meet three times annually to discuss program

design and implementation, review interim results, and address potential challenges to successful implementation.

The *Foundations for Success Project Advisory Board* consists of top scholars with expertise in CGI and in teaching in diverse backgrounds. Table 1 lists the members of the Advisory Board, and their letters of commitment can be found in the Appendices. These members represent diverse perspectives in the field of mathematics education, teacher education, and related Florida education policy. The Advisory Board will meet annually to provide insight into best practices for helping children with diverse backgrounds to succeed in mathematics. Each member will be available for consultation with the Project Director, CGI Implementation Director, and Diversity and Cultural Equity Director to discuss implementation of the teacher PD program and address potential challenges to successful teacher participation and implementation in the classroom. Members of the Advisory Board will also be invited to share their insights directly with teachers at the annual Mathematics and Equity Conference conference.

Table 1. Foundations for Success Project Advisory Board

Name	Association	Expertise
Thomas Carpenter	University of Wisconsin	Cognitively Guided Instruction
Elham Kazemi	University of Washington	CGI teacher PD in high poverty schools
Megan Franke	University of California– Los Angeles	CGI implementation in urban, low performing, schools
Lawrence Morehouse	FEF/McKnight	Development of African American and Hispanic leaders in education
Okhee Lee	New York University	PD for teachers serving bilingual students
Luz Maldonado	Texas State University	Bilingual mathematics education and CGI
Theodore Chao	Ohio State University	Critical pedagogy and equity through mathematics
Julia Aguirre	University of Washington at Tacoma	Culturally responsive mathematics pedagogy

Margaret Walker	Orange County Public Schools/FCTM Past-president	Mathematics instruction in Florida schools serving concentrations of high-needs students
Robert Berry	National Council of Teachers of Mathematics; University of Virginia	Ambitious instruction in high-needs schools; measurement of classroom instruction
Shelly Miedona	Florida Department of Education	Supervision of K–12 mathematics in Florida
Thomas Rhea	Florida Department of Education	Educator development in Florida

A *statistical consultant, Christopher Rhoads*, will provide an external review of evaluation design, data analysis and interpretation of findings. He will be available for consultation by the Project Director and other senior project personnel in each year of the project (to coincide with the planning, data collection, data analysis, and interpretation cycles).

Project Timeline

Project activities will occur according to the following schedule.

Table 2. Schedule of Project Activities (i.e., Timeline)

Activity	2018		2019				2020				2021				2022				2023		
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Initiation and Administration Phase																					
Hire necessary personnel	■	■			■	■															
Obtain/renew approval to conduct research by appropriate review boards at FSU, UM, and participating school districts									■				■				■				■
Hold meeting of the Partnership Board		■	■		■		■			■			■			■			■		
Hold meeting of the Advisory Board								■				■				■				■	
Recruit/enroll teachers to participate in the program and evaluation, giving priority to Title 1 schools and schools with high proportion of Black and Hispanic Students	■	■	■	■			■	■			■	■			■	■					
Recruit/enroll principals to participate in the program and evaluation	■	■			■																
Milestones: Hire personnel, obtain necessary approvals for evaluation, elicit and integrate feedback from district partners and project advisory board, recruit the target number of teachers, where more than 60% of teachers enrolled in the program are teaching in high-needs or high-minority schools																					
Achieve: Goal 1: Provide CGI-based PD in mathematics for teachers in Florida																					
Goal 2: Improve teachers' knowledge...																					
Goal 3: Improve important indicators of teacher quality in mathematics instruction...																					
Provide CGI training for 210 teachers		■	■	■																	
Provide CGI training for 660 teachers			■	■	■	■	■														
Provide CGI training for 720 teachers								■	■	■	■	■									
Provide CGI training for 660 teachers												■	■	■	■						
Provide CGI training for 540 teachers															■	■	■	■			
Milestones: Recruit and enroll teachers to participate in the program each year, analyze and interpret evaluation data, disseminate findings from evaluation study to project partners and other stakeholders																					
Achieve: Goal 4: Enhance the ability of CGI program to positively impact students with the greatest needs...																					
Review literature on scaffolding in elementary-school mathematics for low performing students	■	■																			

Activity	2018		2019				2020				2021				2022				2023		
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Develop and pilot test scaffolds in schools with low performing students																					
Conduct focus group interviews with teachers and supervisors on program designed scaffolds																					
Train teachers on utilizing CGI scaffolds in the classroom to enhance mathematics learning for students with the greatest needs																					
Gather and analyze formative-evaluation data on impacts and utility of scaffolds																					
Hold annual meeting for teachers working in high-poverty schools where they will work and interact with Advisory Board members and other leading educators in the field to develop a personalized commitment to action for their school/classroom																					
Periodic check-in with teachers in high-poverty schools on the implementation of their individual personalized commitment to action. Provide support for modifications if needed.																					
Milestones: Development of CGI scaffolding, training and formative feedback on implementation of scaffold, 75-100 teachers attend annual <i>Mathematics and Equity Conference</i> meeting each year and develop a personalized commitment to action plan																					
Create a cadre of school leaders who are knowledgeable in CGI and can support school level sustainability																					
Goal 5: Establish structures to support teachers' sustained use....																					
Provide CGI training designed specifically for school leaders																					
Follow-up with school leaders on the implementation of CGI in their school																					
Milestone: Principals and school leaders trained to provide teacher support																					
Evaluation and Dissemination																					
Collect teacher pretest data																					
Distribute parental consent letters																					

Activity	2018		2019				2020				2021				2022				2023		
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Collect student pretest data																					
Collect teacher implementation data																					
Collect teacher posttest data																					
Collect Student Achievement Data from school districts (demographic information and district administered student achievement data)																					
Analyze questionnaires and other data sources collected during school year																					
Disseminate findings through Partnership Board meetings, conference presentations, and social media for researchers, educators, and policymakers																					
Disseminate findings through project website and social media for parents/guardians and general public																					
Perform cost analysis and disseminate cost-analysis report to stakeholders																					
Reporting on Project Evaluation to Funding Agency via Annual Reports and conversations with Program Officer																					
Meet with State and Local Leaders to inform them of the status of implementation and evaluation of the program, provide them with information on how to implement the CGI program to other sites statewide																					
Milestones: Administer project measures with teachers and students, Complete Data Analysis and Program Evaluation, Disseminate Findings, Provide information to external SEAs and LEAs about how they can implement the successful parts of the program in their locality																					

Feedback and Continuous Improvement

The project's senior personnel will hold monthly meetings to share information, engage in collaborative problem solving as necessary, and provide updates on progress towards project goals. At the start of the project, senior project personnel will meet with the Partnership Board and the Advisory Board to discuss the program design and implementation plan. The project staff will solicit advice from these two boards on improvements to the proposed plan to increase the successful recruitment of the first cohort of participants. The information received from these meetings will be incorporated in recruiting material and in the planning of workshop activities.

At the conclusion of each year of PD, the Partnership Board will convene to discuss the program progression and address any potential challenges during the next wave of participants. The Partnership Board will be provided by the project staff any preliminary results of teacher and student results. The CGI Implementation Director will take the suggestions from the Partnership Board into consideration during the creation of material for the subsequent year training.

Evaluation Plan

Theory of Change for the *Foundations for Success* Program

Figure 3 depicts the overall theory of change for the *Foundations for Success* program. The program is designed for teachers of grades K–5. The target population includes all elementary teachers and all mathematics students in the state of Florida.

The CGI program is thought to increase early elementary teachers' mathematical knowledge for teaching (MKT), alter their beliefs about mathematics teaching and learning, and change their approach to teaching mathematics. Teachers' knowledge, beliefs, and behaviors are affected incrementally across the three years of the program. Teachers attend the workshops and

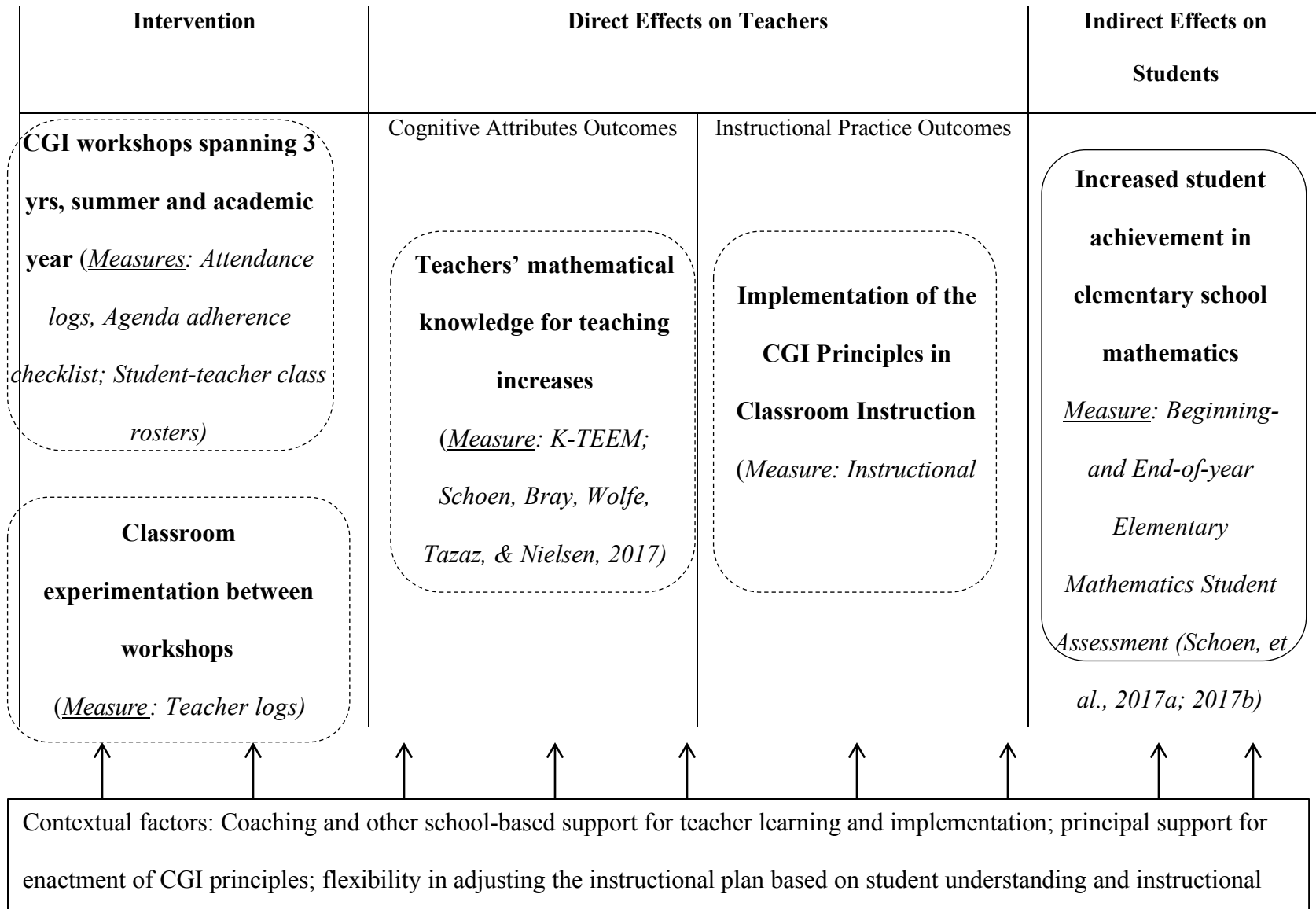


Figure 3. Theory of change for the Foundations for Success program

return to their respective schools to interact with students and colleagues. After interacting with students in their schools, teachers then return to the next round of workshops. In those workshops, they discuss their experiences in their classrooms and are exposed to additional ideas (or to the same ideas but from a new perspective). The teacher change process occurs in an iterative manner over an extended duration of formal and informal experiences. The iterative back-and-forth between workshop and school-based experiences provide opportunities for teachers to situate their learning into their own practice. As a result, teacher-learners play an active role in creating coherence between their daily work and the ideas they encounter in PD. This dynamic allows for the changes in knowledge and beliefs that may occur in the workshops to transfer into long-term, significant changes in instructional practice.

Implementation of CGI in mathematics classrooms contrasts sharply with typical instruction in the U.S. Typical mathematics instruction involves teachers showing children how they should solve problems, focusing on whether answers are correct, and following a prescribed, externally-determined sequence of problems and topics to teach. This has been called the Conventional Direct Recitation approach (Gage, 2009). Rather than the traditional approach, CGI classroom implementation involves engaging students in a problem solving or inquiry-based approach. Instruction in CGI classrooms involves teachers paying close attention to students as they solve problems, and paying close attention to the cognitive processes in students as they solve problems, rather than simply attending to whether they produced a correct answer. CGI classroom instruction also involves teachers making instructional decisions based on what they learn about individual students' cognitive strategies for solving problems, rather than by the externally-imposed sequence of problems, such as that embedded in textbooks, which are invariant to the level of understanding of individual children on any given day. Changes to

teacher instructional practice is considered an outcome at the teacher level, and is conceptualized as the most important mediator of the effect of the program on student achievement.

The cultural backgrounds and experiences students bring to the classroom affect the ways teachers manage the classroom and interact with students. Enactment of the CGI principles involve teachers incorporating students' background and experiences into mathematics instruction. Leading classroom discussions and teaching children how to engage in mathematical practices require different skills in high-poverty classrooms as compared with the classrooms comprised of students coming from families with higher educational levels.

Changes at the teacher level are expected to result in an improvement in student learning outcomes in the domains of number, operations, and algebraic thinking during the year the teacher is participating in the program. The deeper understanding students gain in number, operations, and algebraic thinking at the elementary level is thought to transfer to higher achievement in high school mathematics.

In summary, the *Foundation for Success* theory of change posits that teacher experiences occur in an iterative cycle within and across each year of the CGI program. Incremental changes in teachers' knowledge, beliefs, and instructional practice interact with the workshops over an extended period of time. These changes can be measured and conceptualized as direct outcomes of the CGI program at the teacher level and as mediators of the indirect effect on student understanding and achievement in mathematics.

Research Questions

The summative evaluation design will be guided by the following questions.

1. What is the effect of the *Foundations for Success* program on elementary teachers' mathematical knowledge for teaching as measured by the K- TEEM?

2. What is the effect of the *Foundations for Success* program on cognitive demand and classroom discourse in elementary mathematics classrooms as measured by the IQA?
3. What is the effect of the *Foundations for Success* program on student achievement in mathematics as measured by the EMSA?
4. To what extent do teacher characteristics such as years of experience, race, ethnicity, and baseline mathematical knowledge for teaching moderate the impact of the *Foundations for Success* program on teacher outcomes of interest?
5. To what extent do student characteristics such as race, ethnicity, moderate the impact of the *Foundations for Success* program on teacher outcomes of interest?

To what extent do observable features of classroom instruction in mathematics mediate the effect of the program on student achievement outcomes?

Evaluation Plan Methods Summary

The evaluation design will use multiple methods for monitoring variation in implementation and impact of the program on teacher and student variables of interest. Under the direction of the Project Director and the Diversity and Cultural Competence Director, the graduate students at FSU and UM will review existing data from the past four years of implementation of CGI PD in Florida during the first year of the project. These data include written teacher feedback and evaluations of the workshops, videos of classroom instruction, audio recordings of exit interviews with teachers, and results of data models investigating potential interactions between teacher and student variables and the primary outcomes of interest (i.e., teacher knowledge, teacher instructional practice, and student achievement).

For the impact analyses, the evaluation design will use a cluster-randomized controlled trial research design and hierarchical linear modeling (HLM) to estimate the effect of the CGI

program on teacher and student outcomes, including mathematical knowledge for teaching, instructional practice in mathematics, and student achievement in mathematics. Moderation analysis will enable investigators to identify for whom and under what conditions the CGI program works, while mediation analysis will enable deeper investigation into the causal mechanisms of the effects of the CGI program.

Two-level HLM analyses will describe the impact of the CGPD program on outcomes at the teacher and student levels. Multilevel analyses of covariance will estimate the average treatment effect, test hypothesized moderators, and perform a path analysis to estimate the causal models containing the hypothesized mediators and moderators. Analyses will address the research aims of determining whether the program had an impact on teacher and student outcomes.

A randomized controlled trial intended to measure the impact of the program on students and teachers will occur during the 2018–19 school year. In recent years of CGI implementation in Florida, there have been more than twice as many teachers who apply to participate in the CGI PD program than there have been available seats. Oversubscription to slots in CGI trainings will be leveraged to create lotteries. Randomization will occur at the teacher level within blocks formed by district and training level (i.e., Y1, Y2 or Y3 of the CGI program). School districts and other LEAs in Florida are not providing CGIPD for teachers apart from the work done by FSU and the CGI Math Teacher Learning Program . Linda Levi and the CGI Math -TLC will refrain from contracting with any other agencies in Florida to provide CGI-based PD during the grant award period. As a result, there is virtually no internal validity threat posed by lottery losers seeking CGI training through another venue. While there is a slim possibility of a teacher

arranging for CGI training directly through CGI MATH - TLC by attending an out-of-state workshop, we consider the likelihood of this event to be negligible.

The integrity of the randomization process for this study will be ensured through the following protocol. The Project Director, communications representatives of Partner Districts, and Florida Department of Education will send e-mail notification to invite teachers to apply to participate in the program. Teachers voluntarily applying to register for a CGI training will be asked to consent to participate in the study, which includes randomization of whether they are offered a seat in the training for that year. In year one, the application process will close after 1,320 eligible elementary teachers have applied to participate. The Project Director will use a random number generating function within the statistical package “R” to perform random assignment within each block, with half of the teachers assigned to the treatment condition in school year 2019–20 and the other half assigned to a wait-list control group. The teachers in the wait-list control group who fully participate in data collection during the RCT year will be offered a spot to participate in the training during the 2020–21 school year. Teachers will be informed of their assigned treatment condition by May 15, 2019.

Performance Feedback and Periodic Assessment of Progress

Results of the analysis of teacher feedback, teacher exit interviews, and moderation and mediation analysis based on existing data during year 1 of the program will be shared with the Implementation Director, the Partnership Board, and the Advisory Board during the first quarter of 2018. Results of these analyses and ensuing discussions with these stakeholders will inform the design and implementation of the 8-day CGI workshops implemented during school year 2019–20 and the 2-day *Mathematics and Equity Conference* conference occurring in summer 2019. A similar process will be used with analyses of data generated through the implementation

of the 2019–20 workshops during summer, fall, and winter in 2018–19, and the results will be shared and discussed, once again, with the Partnership Board and Advisory Board.

Smaller cycles of formative evaluation will occur through daily discussions between fidelity observers and workshop leaders. At the end of each summer workshop and academic-year follow-up session, teachers will complete a written evaluation form. Those forms will be reviewed by the Implementation Director and the Project Director on a regular basis to stay abreast of the teachers' experiences in the program and make mid-course corrections as necessary. These ongoing streams of data will be discussed during the weekly meetings of the Project Director, Implementation Director, Diversity and Cultural Equity Director, and the Project Manager.

All of these sources of evaluation data will be continually monitored and will inform the design and implementation of the *Foundations for Success* program. Simple problems of logistics and implementation will be handled by the senior personnel. The Partnership Board and Advisory Board will be on call to assist with difficult problems should they be encountered.

Teacher Outcome Measures

Mathematical Knowledge for Teaching (MKT). Teachers' MKT will be measured at pretest and post-test for the RCT by a web-based assessment instrument developed, field-tested, and validated during CGI efficacy study in Florida. The instrument was designed to be valid for use in identifying effects of PD programs on teacher MKT and is called the Knowledge for Teaching Early Elementary Mathematics (K-TEEM) assessment instrument. The K-TEEM has been field-tested in four distinct waves of data collection. Each wave included more than 200 teachers. A 1-PL model based on item response theory indicated good model fit for all items. In 2014, using a sample of 206 teachers, half of whom had participated in one year of CGI training,

item separation reliability was estimated at .97, person separation reliability was estimated at .79, and person separation indices results indicate the K-TEEM has the ability to discriminate between five to eight levels of performance (Schoen, Bray, Wolfe, Tazaz, & Nielsen, 2017). The instrument has successfully detected treatment effects in three distinct randomized controlled trials of early elementary teacher PD programs (Schoen, LaVenia, LaVenia, & Razzouk, manuscript in progress; Schoen, LaVenia, & Tazaz, 2017; Schoen, Levi, & Tazaz, 2017; Schoen, Secada, & Tazaz, 2015).

Classroom instruction. The Instructional Quality Assessment (IQA; Boston, 2012; Junker et al., 2005) measures several components of classroom instruction organized into two broad categories called *academic rigor* (that is, cognitive demand) and *accountable talk*. The CGI program aims to increase both of these facets of classroom instruction through increasing classroom discourse and cognitive complexity of instructional tasks. The IQA was designed to be used in real-time classroom observations and has been used in recent studies of teacher PD (for example, Boston, 2012; Boston & Smith, 2009; Quint, Akey, Rappaport, & Willner, 2007). Empirical studies indicate that the IQA instrument may generate a stable estimate of teacher instructional practice in as few as two observations (Matsumura, Garnier, Slater, & Boston, 2008).

An instrument validation study for the IQA will occur in project year 1 to gather reliability and validity evidence for the instrument. To establish reliability of the realtime classroom observation instrument, inter-rater reliability (IRR), relative consistency in ratings provided by multiple judges of multiple targets, and inter-rater agreement (IRA), absolute consensus in scores furnished by multiple judges for one or more targets. Indices will be calculated for a random sample of 10% of the yearly observations.

Student Outcome Measures

Elementary Mathematics Student Assessment (EMSA) Test. Beginning-of-year and end-of-year student achievement will be measured by the Elementary Mathematics Student Assessment (EMSA) Test (Schoen, LaVenía, Bauduin, & Farina, 2016a; 2016b; Schoen, Anderson, Champagne, & Bauduin, 2017; Schoen, Anderson, & Bauduin, manuscript in progress). Several versions of the EMSA test exist, and they have been field-tested with thousands of students in grades K–5 over the past four years. Recent versions of the EMSA have been vertically scaled to create a score that is comparable across grades K, 1, and 2 as well as across grades 3, 4, and 5.

Moderators and Mediators

School contextual factors are expected to moderate teacher uptake of the CGI-specific knowledge and impact on student achievement. The level of professional community at a school has been found to be an important determinant of PD impacts on instructional practice (e.g., Doppelt, Schunn, Silk, Mehalik, Reynolds, & Ward, 2009). There is likely to be variation in the proportions of teachers in participating schools who have completed some, or all, of the three-year CGI program. For each participating teacher in the RCT, we will include a factor describing the proportion of teachers in the school who have participated in one or more years of CGI training as a potential moderator of teacher and student outcomes.

Student demographic characteristics, such as race/ethnicity, ELL status, and SES, are consistently found to covary with academic achievement (e.g., Bali & Alvarez, 2004; Okpala, 2002). Studies have found the benefit of particular instructional approaches to vary by student sub-group. For example, Desimone and Long's (2010) investigation of teacher effects and the achievement gap found the use of advanced procedural instruction and time spent on math were

related to achievement growth for traditionally disadvantaged populations, namely Black and low-SES students. We will explore whether treatment effects on student achievement vary across levels of student prior academic achievement, SES, ELL status, and ethnicity.

Data Analyses

The three main impact analyses (for the marginal effects of each year of CGI training) will be identical. We will fit two-level hierarchical linear models to account for the nesting of students within teachers. Models will include fixed effects (dummy variables) for grade level (K–5) and PD Year/school district membership (which also determines the particular lottery in which a teacher will participate). Models will include a beginning-of-school-year student achievement score.

Different levels of oversubscription will likely lead to different probabilities of assignment to treatment for teachers in different blocks. We will account for this using inverse probability of treatment weighting (Stuart, 2010) at the teacher level.

We present below an example of the equations defining our statistical model. Unknown variables that may be added to the model as the result of attrition analyses are, of course, not shown. We let i index students and j index teachers. The model equations are as follows.

Level 1 is specified as: $Y_{ij} = \beta_{0j} + \beta_{1j} (\text{PRES})_{ij} + e_{ij}$.

Level 2 is specified as: $\beta_{0j} = \tau_{00} + \tau_{01} (\text{TREAT})_j + \tau_{02} (\text{PRET})_j + \sum \gamma_{0M} (\text{BLOCK}_M) + \sum \gamma_{0P} (\text{GRADE}_P) + u_{0j}$

$\beta_{1j} = \tau_{10}$

The variables in the above equations are defined as follows: Y_{ij} is the IRT-based, vertically-scaled EMSA score for student i within teacher j . PRES_{ij} is the pretest score for student i within teacher j (centered around teacher mean). TREAT is a dummy variable coded 0 or 1 indicating participating in the relevant year of CGI training. PRET_j is the average student pretest score for

teacher j . The $BLOCK_m$ terms are dummy variables entered into the model to account for lottery membership. The $GRADE_p$ terms are dummy variables entered into the model to account for grade level. The estimate of the τ_{01} term is our estimate of the average effect of the particular year of CGI training (relative to the counterfactual). This term will be standardized into an effect size using the total unconditional standard deviation via procedures described in Hedges (2007).

It is likely that many of the teachers participating in the RCT will be working in the same school, but the school will not be modeled as a third level of nesting (Bloom, Bos, & Lee, 1999; Dong & Lipsey, 2010). In evaluation designs such as this one that randomly assign classrooms to treatment condition, Raudenbush and Sadoff (2008) have shown that the variance for higher-level clusters is split across condition and factored out of the test of the effect of treatment condition. Because randomization of individual teachers will occur at the teacher, “the randomization cancels out the pre-existing clustering effect from schools, just as it cancels out pre-existing effects from unobserved connections between the students such as belonging to the same church, softball team, or play group.” (Lohr, Schochet, & Sanders, 2014, p. 34).

Moderator analysis will be accomplished via a modification of the two-level hierarchical model described above. The model will be slightly different for student level moderators (such as gender) and teacher level moderators (such as number of teachers with at least some CGI training at the school). We consider first the model for student level moderation using eligibility for free or reduced-price lunch (FRL)—a measure of a student’s socioeconomic status—as an example. There are two conceptually different moderating effects of FRL we would like to isolate. The first is the within classroom effect of a student being eligible for free or reduced-price lunch. The second is the contextual effect of the percentage of students in the classroom who are eligible for free or reduced-price lunch. To accomplish this, our model will contain one

variable representing the group mean-centered value of the FRL variable (FRL_{ij}) and another variable representing the percentage of students in the classroom that are FRL ($FRLT_j$). These variables are each interacted with treatment condition to estimate the two moderating effects of interest. Other student level moderators will be treated similarly. Models for teacher-level moderators are equivalent to the above, except with the student-level moderator term removed.

The hypothesized mediating variables are all at the teacher level and mainly consist of measures collected as part of our study of implementation fidelity. Because mediating variables and treatment are measured at level 2 of a multi-level model, but student outcomes are measures at level one, the mediation model is a 2,2,1 model in the terminology of Krull and Mackinnon (2001). As argued in Preacher et al. (2010) these sorts of models are best fit using structural equation modeling software. Accordingly, we will fit all mediational models using path analysis in the Mplus software (Muthén & Muthén, 2010).

Meeting WWC evidence standards

Two main criteria are necessary for studies to meet WWC standards: (1) baseline equivalence between the groups compared must be established, and (2) the combination of differential and overall attrition rates must be low. The RCT described in this proposal is well-positioned to meet WWC evidence standards.

The random assignment procedure used in our RCT should ensure that treatment and control groups are equivalent (in expectation) at the outset of the study. However, it is possible that attrition at the teacher and/or student level may result in a final analytic sample with substantial differences on important baseline prognostic variables. Based on teacher participation and data collection rates achieved in the past two years with Florida samples of schools, teachers, and students participating in CGI PD, we anticipate low attrition rates in this study. Nonetheless,

we will perform a series of analyses meant to provide reassurance that the biasing effect of any missing data is small. We will document both the overall attrition rate and the differential attrition rate (based on the intent-to-treat sample). In a one-year study with random assignment at the teacher level, we anticipate that these two rates taken together will fall well within the WWC range for “low potential for bias.”

Second, we will compare those with complete data in the treatment group to those with complete data in the control group with respect to baseline covariates. These comparisons will be made at both the teacher and student levels. Teacher-level comparisons will be made using the teacher level variables described above (e.g., mathematical knowledge for teaching scores, teaching experience, etc.). Student-level comparisons will utilize prior year test scores for 1st and 2nd graders, beginning-of-year Kindergarten math screeners, and any available demographic information. Standardized mean differences for these variables will be computed, and any variables with differences greater than 0.05 will be adjusted for in the statistical models described in the data analysis section. We do not anticipate differences greater than 0.25. Should they occur, we will acknowledge that there may be reason to doubt the causal validity of estimates provided by the study.

Assuming our expectation of low overall and differential attrition rates is met, the RCT will meet WWC evidence standards without reservations.